Docket No. AUS920010403US1

METHOD AND APPARATUS TO ENCOURAGE CLIENT INTO A DISTRIBUTED PEER TO PEER SHARING TECHNOLOGY

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is related to co-pending U.S. Patent Application Serial No. _____(IBM Docket No. AUS920010398US1) entitled "Method and Apparatus for Wide-Spread Distribution of Electronic Content in a Non-Linear Peer to Peer Fashion" filed even date herewith. The content of the above mentioned commonly assigned, co-pending U. S. Patent applications are hereby incorporated herein by reference for all purposes.

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention relates generally to computer network environments, and more specifically to the mass distribution of data.

2. Description of Related Art:

Current technology for mass distribution of data over the Internet consists of one or more "master" servers where the content is available, and many more "mirror" sites where the same data is stored. These mirror sites do not actually use the data themselves. Typically, the master server is overwhelmed very easily, and end users are forced to manually attempt a list of mirror sites. Each of those mirror sites may or may not actually have the updated content because they are typically driven by time-based automation (typically a

cron job scheduled at midnight). This distribution scheme is incredibly problematic and wasteful in dealing with the initial wave of interest in specific data.

Many of these problems may be reduced by using peer-to-peer technology to offload demands from master servers to other nearby clients which are downloading the same content for their own use. The master server divides a large file into several small pieces and then downloads those file pieces to the first client machines which request the file. For example, a 50 megabyte (MB) file may be broken into 50 1-MB pieces which are then downloaded to 50 different clients. These clients will then function as peer-to-peer servers. Subsequent requests from new client machines are then redirected by the master server to the clients which already have the required file pieces.

Because the client machine are owned by the end users, acquiring peer-to-peer connections may be a significant problem if people do not want to share their bandwidth and computer resources.

Therefore, it would be desirable to have a method for providing incentive for end users to allow their client machine to act as peer-to-peer servers.

SUMMARY OF THE INVENTION

The present invention provides a method, program and system to provide incentives for client machines to contribute resources to a peer-to-peer computer network. When a server receives requests for information from a plurality of client machines, it determines if the client machines are contributing resources to peer-to-peer sharing. When answering requests, clients which contribute resources to peer-to-peer sharing are given priority over clients which do not contribute. In another embodiment of the present invention, a further incentive is provided to clients which contribute to peer-to-peer sharing, by giving higher priority to client requests in proportion to the level of resources contributed.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 depicts a pictorial representation of a network of data processing systems in which the present invention may be implemented;

Figure 2 depicts a block diagram of a data processing system that may be implemented as a server in accordance with a preferred embodiment of the present invention;

Figure 3 depicts a block diagram illustrating a data processing system in which the present invention may be implemented; and

Figure 4 depicts a flowchart illustrating a method for encouraging clients to contribute resources to peer-to-peer sharing in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to the figures, **Figure 1** depicts a pictorial representation of a network of data processing systems in which the present invention may be implemented. Network data processing system **100** is a network of computers in which the present invention may be implemented. Network data processing system **100** contains a network **102**, which is the medium used to provide communications links between various devices and computers connected together within network data processing system **100**. Network **102** may include connections, such as wire, wireless communication links, or fiber optic cables.

In the depicted example, a server **104** is connected to network **102** along with storage unit **106**. In addition, clients **108**, **110**, and **112** also are connected to network **102**. These clients **108**, **110**, and **112** may be, for example, personal computers or network computers. In the depicted example, server **104** provides data, such as boot files, operating system images, and applications to clients **108-112**. Clients **108**, **110**, and **112** are clients to server **104**. Network data processing system **100** may include additional servers, clients, and other devices not shown.

In the depicted example, network data processing system **100** is the Internet with network **102** representing a worldwide collection of networks and gateways that use the TCP/IP suite of protocols to communicate with one another. At the heart of the Internet is a backbone of high-speed data communication lines between major nodes or host computers, consisting of thousands of commercial, government, educational and other computer systems that

route data and messages. Of course, network data processing system **100** also may be implemented as a number of different types of networks, such as for example, an intranet, a local area network (LAN), or a wide area network (WAN). **Figure 1** is intended as an example, and not as an architectural limitation for the present invention.

Referring to **Figure 2**, a block diagram of a data processing system that may be implemented as a server, such as server **104** in **Figure 1**, is depicted in accordance with a preferred embodiment of the present invention. Data processing system **200** may be a symmetric multiprocessor (SMP) system including a plurality of processors **202** and **204** connected to system bus **206**. Alternatively, a single processor system may be employed. Also connected to system bus **206** is memory controller/cache **208**, which provides an interface to local memory **209**. I/O bus bridge **210** is connected to system bus **206** and provides an interface to I/O bus **212**. Memory controller/cache **208** and I/O bus bridge **210** may be integrated as depicted.

Peripheral component interconnect (PCI) bus bridge **214** connected to I/O bus **212** provides an interface to PCI local bus **216**. A number of modems may be connected to PCI bus **216**. Typical PCI bus implementations will support four PCI expansion slots or add-in connectors. Communications links to network computers **108-112** in **Figure 1** may be provided through modem **218** and network adapter **220** connected to PCI local bus **216** through add-in boards.

Additional PCI bus bridges **222** and **224** provide interfaces for additional PCI buses **226** and **228**, from which additional modems or network adapters may be supported. In this manner, data processing system **200** allows connections to multiple network computers. A memory-mapped graphics adapter **230** and hard disk **232** may also be connected to I/O bus **212** as depicted, either directly or indirectly.

Those of ordinary skill in the art will appreciate that the hardware depicted in **Figure 2** may vary. For example, other peripheral devices, such as optical disk drives and the like, also may be used in addition to or in place of the hardware depicted. The depicted example is not meant to imply architectural limitations with respect to the present invention.

The data processing system depicted in **Figure 2** may be, for example, an IBM RISC/System 6000 system, a product of International Business Machines Corporation in Armonk, New York, running the Advanced Interactive Executive (AIX) operating system.

With reference now to **Figure 3**, a block diagram illustrating a data processing system is depicted in which the present invention may be implemented. Data processing system **300** is an example of a client computer. Data processing system **300** employs a peripheral component interconnect (PCI) local bus architecture. Although the depicted example employs a PCI bus, other bus architectures such as Accelerated Graphics Port (AGP) and Industry Standard Architecture (ISA) may be used. Processor **302** and main memory **304** are connected to PCI local bus **306** through PCI bridge **308**. PCI bridge **308** also may include an integrated memory controller and cache

memory for processor **302**. Additional connections to PCI local bus **306** may be made through direct component interconnection or through add-in boards. In the depicted example, local area network (LAN) adapter **310**, SCSI host bus adapter **312**, and expansion bus interface **314** are connected to PCI local bus **306** by direct component connection. In contrast, audio adapter **316**, graphics adapter **318**, and audio/video adapter **319** are connected to PCI local bus **306** by add-in boards inserted into expansion slots. Expansion bus interface **314** provides a connection for a keyboard and mouse adapter **320**, modem **322**, and additional memory **324**. Small computer system interface (SCSI) host bus adapter **312** provides a connection for hard disk drive **326**, tape drive **328**, CD-ROM drive **330**, and DVD drive **332**. Typical PCI local bus implementations will support three or four PCI expansion slots or add-in connectors.

An operating system runs on processor **302** and is used to coordinate and provide control of various components within data processing system **300** in **Figure 3**. The operating system may be a commercially available operating system, such as Windows 2000, which is available from Microsoft Corporation. An object oriented programming system such as Java may run in conjunction with the operating system and provide calls to the operating system from Java programs or applications executing on data processing system **300**. "Java" is a trademark of Sun Microsystems, Inc. Instructions for the operating system, the object-oriented operating system, and applications or

programs are located on storage devices, such as hard disk drive **326**, and may be loaded into main memory **304** for execution by processor **302**.

Those of ordinary skill in the art will appreciate that the hardware in **Figure 3** may vary depending on the implementation. Other internal hardware or peripheral devices, such as flash ROM (or equivalent nonvolatile memory) or optical disk drives and the like, may be used in addition to or in place of the hardware depicted in **Figure 3**. Also, the processes of the present invention may be applied to a multiprocessor data processing system.

As another example, data processing system **300** may be a stand-alone system configured to be bootable without relying on some type of network communication interface, whether or not data processing system **300** comprises some type of network communication interface. As a further example, data processing system **300** may be a Personal Digital Assistant (PDA) device, which is configured with ROM and/or flash ROM in order to provide non-volatile memory for storing operating system files and/or user-generated data.

The depicted example in **Figure 3** and above-described examples are not meant to imply architectural limitations. For example, data processing system **300** also may be a notebook computer or hand held computer in addition to taking the form of a PDA. Data processing system **300** also may be a kiosk or a Web appliance.

In peer-to-peer data distribution, acquiring peer-to-peer connections may be a significant problem if end users do not want to share their bandwidth and computer resources. The present invention provides

incentives for the owners of client machines to contribute their resources to peer-to-peer sharing technology.

Referring to **Figure 4**, a flowchart illustrating a method for encouraging clients to contribute resources to peer-to-peer sharing is depicted in accordance with the present invention. On the master server, requests for files will be answered first for peer-to-peer servers and secondly for clients in the normal fashion used today. When the master server receives a file request from a client (step **401**), the master determines if that client has adopted peer-to-peer sharing technology (step **402**). If the client is not contributing resources for peer-to-peer sharing, the file request will still be granted, but the request is placed into the "slow lane" of the pending file transfers (step **403**). If the client is contributing resources for peer-to-peer sharing, the master server places the request in the "fast lane" (step **404**). Client requests given fast lane status are always given higher priority than requests with slow lane status.

In contributing to peer-to-peer sharing, clients would be allowed to delegate a "sandbox" for the protocol to use. This includes specific disk space limits, bandwidth limits, CPU limits, memory limits, and limits on number of users connecting.

The caveat of the present approach is that some users may select minimal resources necessary in order to get into the fast lane of the peer-to-peer servers. To address the problem, the master server maintains a priority queue for requests that are in the fast lane. This priority queue evaluates the level of resources that

the peer-to-peer client has contributed to sharing technology (step **405**). The priority queue considers factors such as the client's resources and the client's past history of serving other clients. Priority within the queue is then assigned in proportion to the total resources contributed to the peer-to-peer sharing technology (step **406**). This priority queue adds another layer of priority to client requests, on top of the fast lane/slow lane distinction described above. Therefore, end users have an incentive to offer more resources (bandwidth, disk space, CPU, memory, etc.) towards sharing so that they receive files faster.

It is important to note that while the present invention has been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in the form of a computer readable medium of instructions and a variety of forms and that the present invention applies equally regardless of the particular type of signal bearing media actually used to carry out the distribution. Examples of computer readable media include recordable-type media, such as a floppy disk, a hard disk drive, a RAM, CD-ROMs, DVD-ROMs, and transmission-type media, such as digital and analog communications links, wired or wireless communications links using transmission forms, such as, for example, radio frequency and light wave transmissions. The computer readable media may take the form of coded formats that are decoded for actual use in a particular data processing system.

The description of the present invention has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiment was chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.